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ENGINEERING SERVICE CENTER
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METHOD OF TEST FOR SERIES MULTIPLE (SM) TRANSFORMERS

CAUTION: Prior to handling test materials, performing equipment setups, and/or conducting this method, testers are required to read "**SAFETY AND HEALTH**" in Section F of this method. It is the responsibility of whoever uses this method to consult and use departmental safety and health practices and determine the applicability of regulatory limitations before any testing is performed. Users of this method do so at their own risk.

A. SCOPE

This method covers the procedure for measuring the no load and full load voltage and temperature rise of series multiple transformers with constant current of 6.6 amperes.

B. APPARATUS: TYPICAL

1. 10 KVA single phase, 60 Hz AC, 6.6 amp constant current transformer, General Electric type RO2 with auxiliary controls.
2. Yokogawa Digital Power Factor Meter Model 2524.
3. Magtrol Power Analyzer Model 4612.
4. Tektronix Oscilloscope Model 2465.
5. Electro Scientific Industries, Ohmmeter Model 1705B.
6. Light bulbs of various voltages and a variable resistor for loading.

7. Load consisting of SM (Series Multiple) transformers or series ballasts with lamp load.

C. TEST PROCEDURE FOR NO LOAD AND FULL LOAD VOLTAGE

1. Arrange the apparatus as shown in Figure 1 with commercial power off.
2. Load the 6.6 amp series circuit outputs A through E with approximately 2 KVA load consisting of SM transformers and/or series ballasts with load including the SM transformer under test. Disconnect the series circuit shorting switches for the outputs that are loaded with transformers and make certain that the outputs which have no transformers connected to them are shorted with the shorting switch.
3. Note the volt-ampere capacity of the SM transformer to be tested. Determine the approximate full load current output at rated voltage of the SM transformer. The full load current output is equal to:

$$\frac{\text{volt-ampere capacity of transformer under test}}{\text{rated output voltage.}}$$

Connect the current transformer to the lamp load line such that the current through the ammeter will not exceed the ammeter current capacity when full load is applied to the transformer.

4. From the volt-ampere capacity of the SM transformer, determine the number and wattage sizes of incandescent lamps to fully load the transformer. One lamp should be connected through a variable resistor to give a fine final volt-ampere adjustment.
5. With the lamp load switches in the off position, turn on the power to the constant current transformer, and after the series circuit ammeter has stabilized to 6.6 amps., read the SM transformer output voltage on the voltmeter at no-load and record as no-load voltage.
6. Load the SM transformer under test by closing the switches to as many lamps and adjusting the variable resistor such that the product of the output current and the output voltage equals the volt-ampere capacity of the SM transformer under test. Record the observed voltmeter reading as the full-load output voltage.
7. Before disconnecting the transformer, turn off the commercial power to the constant current transformer.
8. Do not make corrections for instrument losses.

D. TEST PROCEDURE FOR TEMPERATURE RISE MEASUREMENTS

1. Keep SM transformers to be tested in room temperature of $25^{\circ}\text{C} \pm 3^{\circ}\text{C}$ for 24 hours before testing for temperature rise.

2. Using the Electro Scientific Industries, Ohmmeter Model 1705B, measure the secondary coil resistance of the SM transformer with the primary coil open circuited.
3. Record the room temperature, T_1 , in degrees C and the coil resistance, R_1 .
4. Arrange the apparatus as shown in Figure 1 with commercial power off.
5. Connect the SM transformers to the 6.6 amp series circuit outputs A through E. Disconnect the series circuit shorting switches for the outputs that are loaded with SM transformers and make certain that the outputs which have no transformers connected to them are shorted with the shorting switches.
6. Note the volt-ampere capacity of each transformer being tested for temperature rise and connect sufficient load to each transformer approximately equal to its volt-ampere capacity.
7. Turn on the power to the constant current transformer. Adjust the lamp load so that the product of the SM transformer output voltage and current exceeds the volt-ampere capacity of transformer by 10 percent.
8. Leave transformers on in the overload condition for 4 hours. After 4 hours, reduce the load to equal the volt-ampere capacity of the transformer. Wait 2 more hours.
9. Turn off the commercial power. Disconnect both primary and secondary wires of the transformers. Measure the secondary coil resistance as in step D-2.
10. Record the coil resistance, R_2 .
11. Connect the transformer back in the circuit. Turn on the commercial power to the constant current transformer. Wait 15 minutes or more.

12. Repeat steps C-9 through C-11 at least 2 more times until no further change is observed in the secondary coil resistance.
13. Repeat steps C-9 through C-12 for each of the remaining transformers.
14. The temperature rise shall be determined after the temperature of the transformer has become constant. The temperature shall be considered constant when 3 successive readings of the resistance taken at minimum intervals of 15 minutes indicate no change.
15. The resistance measurement of the transformer shall be completed within 4 minutes after shut-down to get an accurate reading.
16. The temperature rise shall be calculated as follows:

$$T = [(R_2 - R_1) / R_1] \times (234.5 + T_1)$$

Where:

T = Temperature rise.

R₁ = Cold resistance of transformer coil.

R₂ = Hot resistance of transformer coil.

T₁ = Room temperature in degrees C.

17. Turn off the commercial power. Close the series circuit shorting switches before removing the transformer.

E. REPORTING OF RESULTS

Report results on Form TL-6039.

F. SAFETY AND HEALTH

The output voltage of the Constant Current Transformer ranges from 1,500 volts loaded to 2,100 volts open-circuit voltage; therefore, extreme care must be taken not to get in contact with any live parts.

Prior to handling, testing or disposing of any waste materials, testers are required to read: Part A (Section 5.0), Part B (Sections: 5.0, 6.0 and 10.0) and Part C (Section 1.0) of Caltrans Laboratory Safety Manual.

Users of this method do so at their own risk.

End of Test (California Test 646 contains 4 pages)

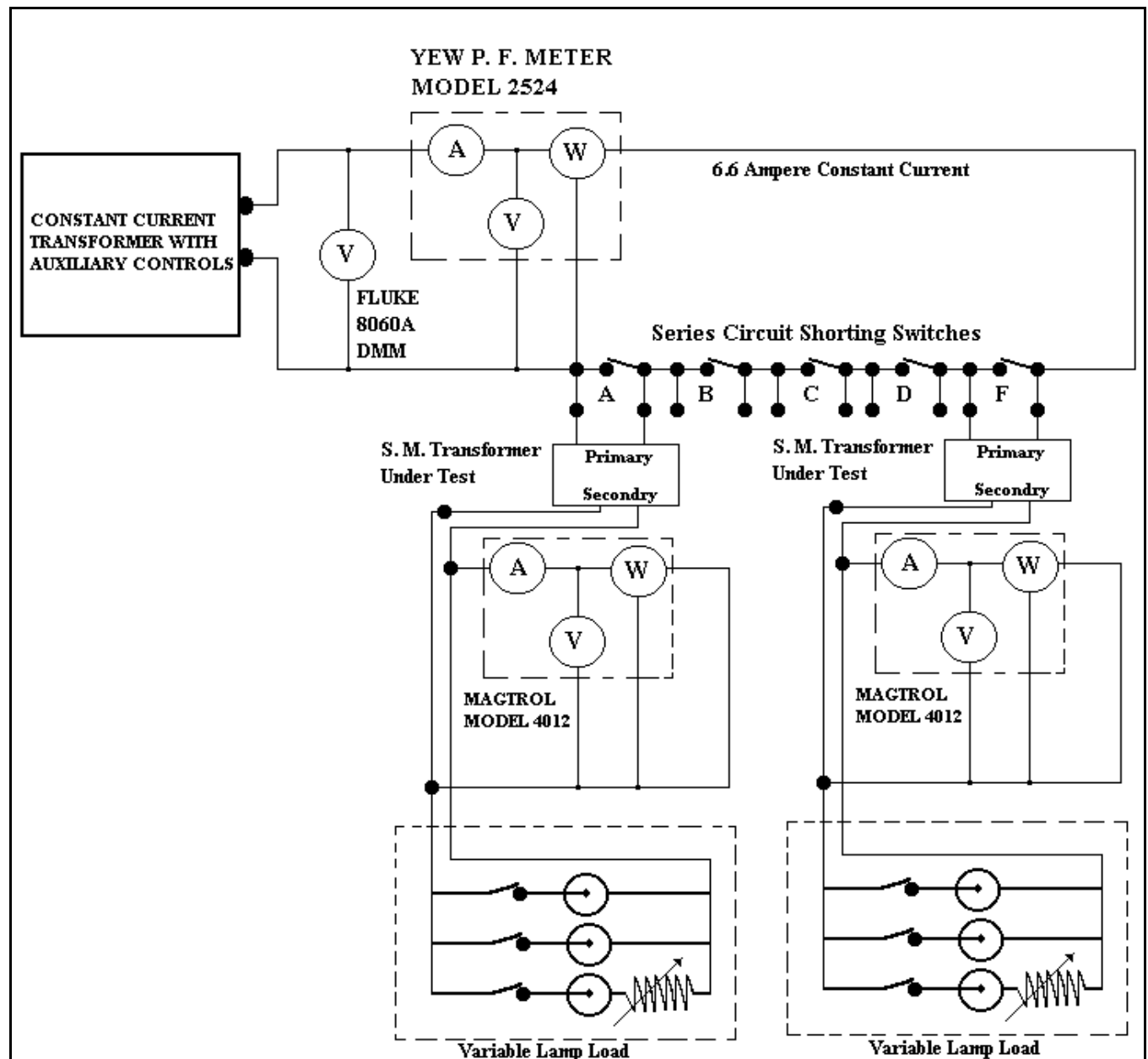


Figure 1.